ROCKFORD INSTRUMENT LAB
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# INSTRUCTION MANUAL

# MODEL 134
# DIGITAL MULTIMETER

## CALIBRATION
## OPERATION
## MAINTENANCE

MP MASTER
MA28612

DATA PRECISION
*... years ahead*

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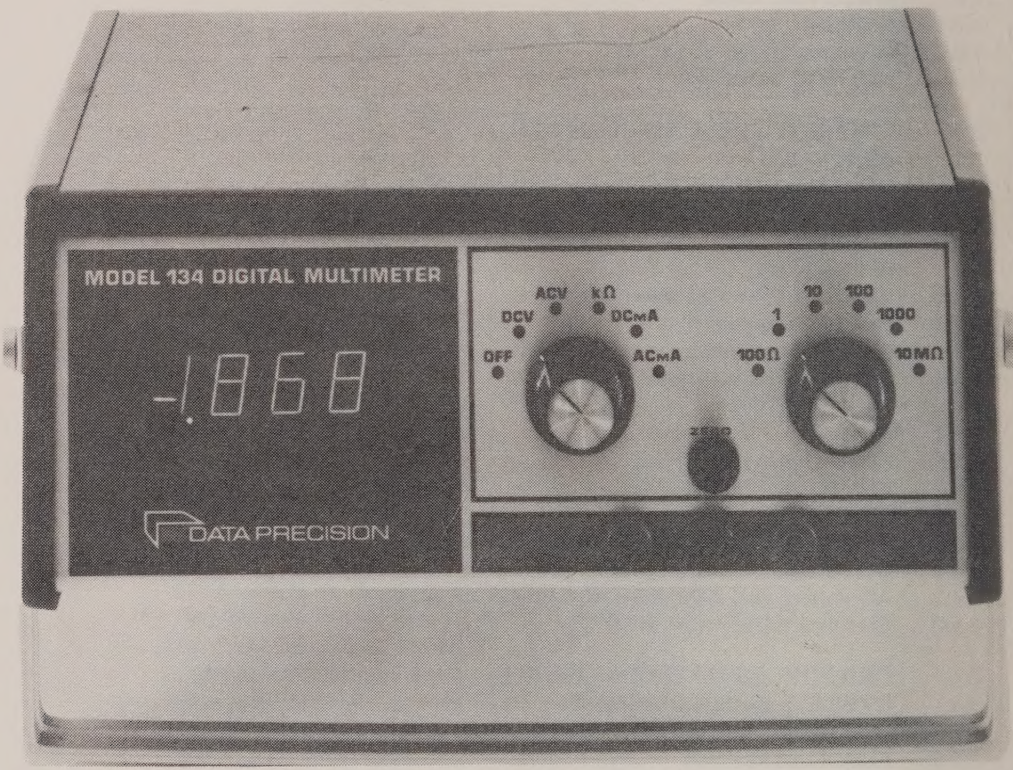
Contents

1 INTRODUCTION
1.1 GENERAL
1.2 UNPACKING
1.3 SPECIFICATIONS
1.3.1 General
1.3.2 Measurement Specifications
1.4 SCOPE OF MANUAL

2 OPERATION & CALIBRATION
2.1 GENERAL
2.2 OPERATING CONTROLS AND INDICATORS
2.2.1 Front Panel
2.2.2 Rear Panel
2.3 OPERATION
2.3.1 General and Pre-Operation Checks
2.3.2 Voltage Measurements
2.3.3 Current Measurements
2.3.4 Resistance Measurements
2.4 CALIBRATION
2.4.1 General
2.4.2 ZERO (Front Panel, R14)
2.4.3 A/D ZERO (Internal, R19)
2.4.4 Fine Zero
2.4.5 Ohms Adjust (DC ADJ, R25; 10 MEG ADJ, R32)
2.4.6 DC Voltage (A/D CAL, R48)
2.4.7 AC Voltage (AC ADJ, R24; AC TRIMS C21, C23)
2.4.8 DC Current (X10 ADJ, R17)

3 PRINCIPLES OF OPERATION
3.1 OVERALL BLOCK DIAGRAM
3.2 CONTROLS AND ADJUSTMENTS
3.2.1 Front Panel Controls
3.2.2 Internal Calibration Controls
3.3 CIRCUIT SCHEMATIC
3.4 INPUT SIGNAL CONDITIONER
3.5 BUFFER/AMPLIFIER
3.6 ABSOLUTE VOLTAGE–TO–CURRENT CONVERTER
3.7 CURRENT–TO–FREQUENCY CONVERTER
3.8 CONTROL LOGIC
3.9 POWER SUPPLY

4 MAINTENANCE
4.1 GENERAL
4.2 TROUBLE-SHOOTING AND FAULT DIAGNOSIS
4.3 MAINTENANCE AIDS


MODEL 134 DIGITAL MULTIMETER
-1.868
DATA PRECISION
OFF
DCV
ACV
kΩ
DCmA
ACmA
1
10
100
1000
100Ω
10MΩ
ZERO

# Chapter 1

# INTRODUCTION

## 1.1 GENERAL

Data Precision Model 134 Digital Multimeter (frontispiece) is a low-cost, high-performance, 3 1/2 digit instrument. It operates in any of five measuring modes: AC and DC voltage, AC and DC current, and resistance, on a total of 22 range scales. Maximum voltages up to 1500 VDC or 1000 VAC RMS and resistances up to 20 megohms may be measured with the basic instrument. Higher voltages, up to 30,000 VDC, may be measured using the optional High Voltage Probe Accessory. On every range, measurements may be made up to 200% of full scale range (up to the instrument limits of voltage). The multimeter is protected by internal circuitry so that extremely high voltages or currents (within very broad limits) will not result in damage in the event of improper connections or even by selecting the lowest range scales for the maximum inputs.

By using the optional Isolation Probe, the Model 134 Digital Multimeter may be used to make accurate DC measurements on high-Q tuned amplifiers and oscillators, such as in RF and IF stages, without detuning the measured circuit.

## 1.2 UNPACKING

Each Model 134 Digital Multimeter is shipped with the necessary probe set and instructions for immediate use. The package should contain the following items:

a) 1 Model 134 Digital Multimeter (with line power cord attached)

b) 1 set of Test Probes (1 red and 1 black)

c) Instruction Manual (Operation and Maintenance)

d) Warranty Card (1 year Warranty)

Check to see that each of the listed items has been included in your shipment. Contact the factory immediately to replace any missing item. Carefully inspect the shipping container and the equipment for any signs of damage or rough handling in transit. Notify the shipping agent at once if any damage is discovered; submit claim to shipping agent for any apparent or concealed damage in transit.

Fill out the warranty card and return it to the factory. Each instrument performance is sold with one full year warranty and your purchase of the unit must be registered at the factory to assure proper coverage under the terms of the warranty.

If an optional probe set (Hi-Voltage or Isolation) has been ordered, it will be shipped in its own container and should be inspected and checked according to the instruction packed with it.

## 1.3 SPECIFICATIONS

### 1.3.1 General

The following specifications for the Model 134 Digital Multimeter are applicable to the performance in all measurement modes and on all range scales.

Size: 3 1/2" high x 7 1/8" wide x 8 7/8" deep
Weight: 4 1/4 lbs
Power: 15 watts from 117 VAC, 60Hz, 100VAC 50 Hz, or 230VAC 50 Hz.

Operating Temperature & Temperature Stability:
Range: 15°C to 45°C
Temperature
Coefficient: ±0.025% of rdg/°C on DC Volts
±0.05% of rdg/°C all others

Polarity Indication for DC voltage and current: Positive measurements are indicated with no polarity sign; Negative measurements are indicated with minus sign – no sign is displayed for other functions.

Out-of-Range: (Beyond overrange value for the selected scale) Most significant (left) digit, "1," is lighted, the other 3 digits are blanked, and the decimal point is lighted. If negative DC out-of-range, the minus (-) sign will also light.

### 1.3.2 Measurement Specifications

The performance specified for each function of multimeter operation is listed in the table that follows.

All specifications apply over the operating temperature range of 20°C to 30°C. Beyond this temperature range, the performance is determined by the specified temperature coefficient.

## 1.4 SCOPE OF MANUAL

This manual contains instructions for operation, calibration, and maintenance of the Model 134 Digital Multimeter. Read the instructions carefully before operating the instrument. Observe caution in attempting to recalibrate.

| | DC Voltage | AC Voltage | DC Current | AC Current | Resistance |
|---|---|---|---|---|---|
| Ranges | —<br>±0 to 1.000 VDC<br>10.00<br>100.0<br>1000.<br>— | —<br>0 to 1.000 VRMS<br>10.00<br>100.0<br>1000.<br>— | —<br>±0 to 1.000 DCmA<br>10.00<br>100.0<br>1000.<br>— | —<br>0 to 1.000 mARMS<br>10.00<br>100.0<br>1000.<br>— | 0 to 1.000K<br>1.000 KΩ<br>10.00 KΩ<br>100.0 KΩ<br>1000. KΩ<br>10.00 MΩ |
| Over Range | —<br>±0 to 1.999 VDC<br>19.99<br>199.9<br>1500.<br>— | —<br>0 to 1.999 VRMS<br>19.99<br>199.9<br>1000.<br>— | —<br>±0 to 1.999 DCmA<br>19.99<br>199.9<br>1999.<br>— | —<br>0 to 1.999 mARMS<br>19.99<br>199.9<br>1999.<br>— | 0 to 199.9 Ω<br>1.999 KΩ<br>19.99 KΩ<br>199.9 KΩ<br>1999. KΩ<br>19.99 MΩ |
| Accuracy | ±0.2% rdg ±0.2% Range thru 100 Range<br>±0.6% rdg ±0.4% Range on 1000 Range | ±1% rdg ±0.6% Range thru 100 Range<br>±2% rdg ±0.6% Range on 1000 Range | ±0.8% rdg ±0.5% Range thru 100 mA Range<br>±1.8% rdg ±0.5% on 1000 mA Range | ±1.3% rdg ±0.5% Range thru 100mA Range<br>±2.3% rdg ±0.5% Range on 1000mA Range | ±0.8% rdg ±o.5% R thru 1000kΩ Range<br>±1.8% rdg ±0.5% R on 10MΩ Range |
| Freq. Response | — | 50 Hz – 1 KHz, 1% R ≤ 100<br>1.5% R = 1000<br>±0.5dB 1KHz to 10 KHz<br>R = 1, 10<br>±1.0 dB, R = 100<br>±1. dB 1KHz to 2KHz<br>R = 1000 | — | 50 Hz to 1 KHz<br>to 50 KHz at reduced accuracy | — |

Chapter 2

# OPERATION & CALIBRATION

## 2.1 GENERAL

Measurements are made with the Model 134 Multimeter by using the test probes to connect the meter input terminals to the voltage, current, or resistance circuit to be measured. Polarity of a DC measurement is automatically indicated on the Model 134 display; no sign indicates positive polarities; a minus indicates negative polarities. In both cases, sign information represents the relative polarity of the signal connected to the HI or 1000 mA jack with respect to the LO jack as a reference. (The 1000mA jack is used for measurements of current between 200mA and 2000mA.)

The range scale for a measurement in any function is selected by a frontpanel rotary switch; the indication of out-of-range (overload) input for the selected range scale is automatically displayed by the blanking of the last 3 digits, while the most significant digit remains lighted as a "1," and the range-selected decimal point and polarity sign (if on) stay lighted.

The decimal point is automatically positioned in the display as part of the operation of the range selection switch so that the meter provides a direct reading in voltage (VOLTS), or current (MILLIAMPS). Resistance readings are also direct in ohms, kilohms, and megohms, as indicated on the front panel range selector legends.

The standard test probes may be used for measurements up to 1500 VDC or 1000 VAC, RMS and where capacitive loading by the meter and probes does not affect the circuit being measured. For high voltages (over the specified standard limits) up to 30,000 volts, an accessory High Voltage Probe may be used; an Isolation Probe accessory may be used which isolates the measured circuit from the metering circuit. Operating instructions for these accessories are supplied with these options, when ordered.

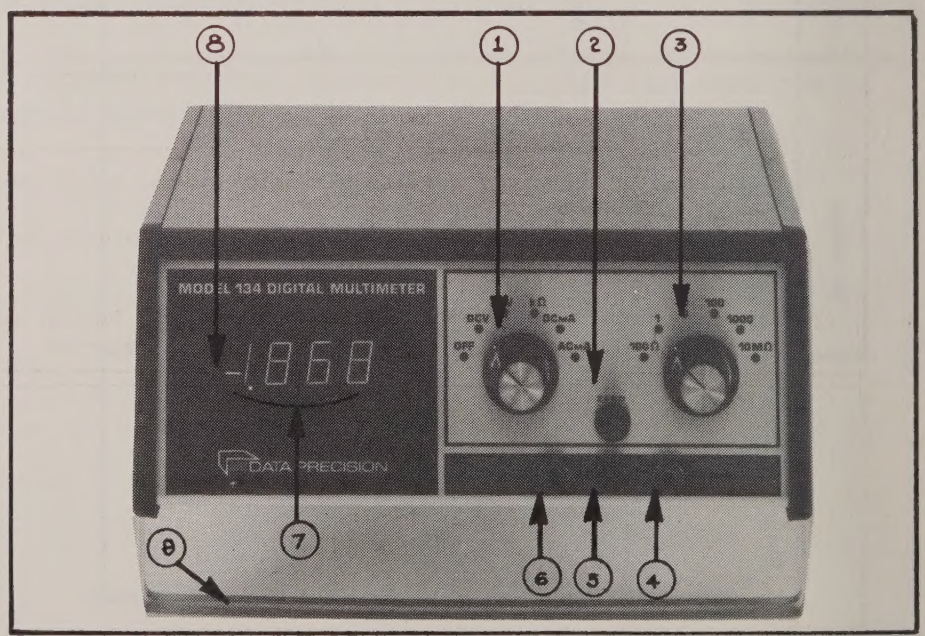



Figure 2-1. Front Panel Controls and Indicators

## 2.2 OPERATING CONTROLS AND INDICATORS

### 2.2.1 Front Panel (See Figure 2-1)

| Illust. ID# | Title | Description (Operation) |
|---|---|---|
| 1 | Function | 6-Position Rotary Switch. Selects 1 of 5 modes of meter measurement and turns meter power off. |
| 2 | ZERO | Potentiometer R14 Control. Adjusts display reading to 000 for zero value input. |
| 3 | RANGE | 6-Position Rotary Switch. Selects one of 4 full-scale ranges for voltage or current measurements and one of 6 full-scale ranges for resistance measurements. |
| 4 | HI | Terminal,Connects Hi level of input signal for all ranges of voltage and resistance measurements, and current measurements other than when using the 1000mA scale. |
| 5 | LO | Terminal,Connects LO (reference) level of signal on all ranges and functions. |
| 6 | 1000mA | Terminal Connects Hi level of input signal when using 1-ampere (1000mA) full-scale range. |
| 7 | Display | Display Numerals. Most significant digit is "1" or blank; others are 0 to 9, depending upon measured value. Decimal point location is positioned according to range selected. |
| 8 | Polarity | Positive polarity on DC measurements indicated by blank. Negative polarity indicated by "-" (minus sign). |
| 9 | Handle | Adjustable handle. For carrying, or as a stand for bench use. |

### 2.2.2 Rear Panel (Figure 2.2)

| Illust. ID # | Title | Description |
|---|---|---|
| 10 | Line Cord | 3-Wire Line Power Cord. Applies source power to multimeter. |
| 11 | Fuse | 2.5-Amp. Current measurement. Protects instrument from high current overloads. |
| 12 | Fuse | 1/4-Amp. Slo-Blo. Mounted inside rear panel. Protects instrument and power source from excess primary line current. |

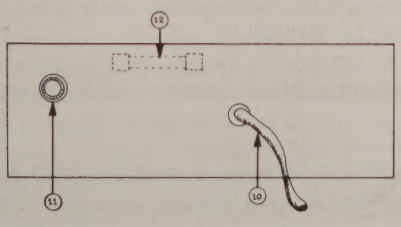



**Figure 2-2. Rear Panel Controls**

## 2.3 OPERATION

### 2.3.1 General and Pre-Operation Checks

a) Connect the line power cord to AC source (115V± 10%, 60 Hz).

b) Allow instrument to warm up for 15 minutes.

c) Select the OHMS measuring function. The display should indicate an out-of-range condition. (Three least significant digits blank; most significant "1" lighted.)

d) Connect the probes to the meter. Short the probes together and observe a near-zero reading on the Display.

e) Adjust the Meter Zero as follows:

1) Select the DCmA measuring function.

2) Position the Range switch to the 1 scale position.

3) Turn the ZERO adjust knob on the front panel until the negative polarity sign "-" just flickers off, and the display reads ".000".

f) If unable to Zero, see Calibration procedures (Paragraph 2.4).

### 2.3.2 Voltage Measurements

a) Select the appropriate Function Measurement, ACV or DCV, for the measurement to be made, and the highest range expected.

b) Connect the test probes ACROSS the potential to be measured; HI one side, LO to other.

c) For DC readings no polarity sign indicates the lead connected to the HI jack is positive with reference to the lead connected to LO. If negative, the (-) sign will be displayed.

d) For DCV measurements, the displayed value is read directly in Volts DC.

e) For ACV measurements, the displayed value is read directly in RMS Volts.

f) When Out-of-Range measurements are indicated, (as described above) change to a higher range scale, if possible. If the input voltage may exceed the 1500 VDC or 1000 VAC limits, then the optional high voltage probe, Model V-35, should be used.

### 2.3.3 Current Measurements

Remember: The meter is placed in series with the current flow in order to measure current. Overload protection devices are incorporated into the circuit to protect against improper meter connections, but damage may result to the circuit being measured if very high currents are drawn by the meter.

a) Select the ACmA or DCmA function, as appropriate, and the highest full scale range expected.

b) Connect the HI and LO meter terminals in series with the load through which the current is to be measured.

c) The measured value is direct reading in milliamperes, and the AC value is mARMS.

CAUTION: CURRENTS IN EXCESS OF 2 AMPERES MAY BLOW THE PROTECTING FUSE F1, ON REAR PANEL.

d) If an Out-of-Range indication appears on 100mA full-scale, or if more than 200 mA is to be measured, then, AFTER REMOVING CIRCUIT POWER, connect the circuit to be measured between the "1000mA" and "LO" terminals of the meter, select the 1000mA range scale, turn on CIRCUIT POWER, and read the measured value on the display.

NOTE: THIS RANGE DOES NOT HAVE FUSE PROTECTION.

### 2.3.4 Resistance Measurements

CAUTION: Resistance Measurements must be made while power is removed from the circuit to be tested.

a) Select KΩ measurement function, and highest range scale for expected measurement value.

b) Connect probes across the resistance to be measured. (Note-connections to other circuit components may affect measured values).

c) Measured value is displayed as below.

| Range Scale | Units |
|---|---|
| 100Ω | ohms |
| 1 | kilohms |
| 10 | kilohms |
| 100 | kilohms |
| 1000 | kilohms |
| 10MΩ | Megohms |

d) Each range is direct reading, and each range allows 100% overrange before an overload indication appears. **Note:** Each range, except 100Ω, is protected up to + or − 250 VDC or 180 VRMS AC. The 100Ω range is protected to +100 VDC, −250 VDC or 180 VAC RMS.

## 2.4 CALIBRATION

### 2.4.1 General

To calibrate, lift the top cover after removing the two screws at the rear, and obtain access to the calibrating adjustments as identified in Figure 2.3. Perform the calibrating tests in the sequence described below. Calibrating test standards should have an accuracy of 5 to 10 times better than the specified performance of the multimeter for the voltages and frequency ranges concerned. Refer to Chapter 3 and to the circuit schematic for additional information about the operation of the components called out in the procedure. The PC board is marked with component nomenclature, and all components are mounted on top of the board and are accessible on top.

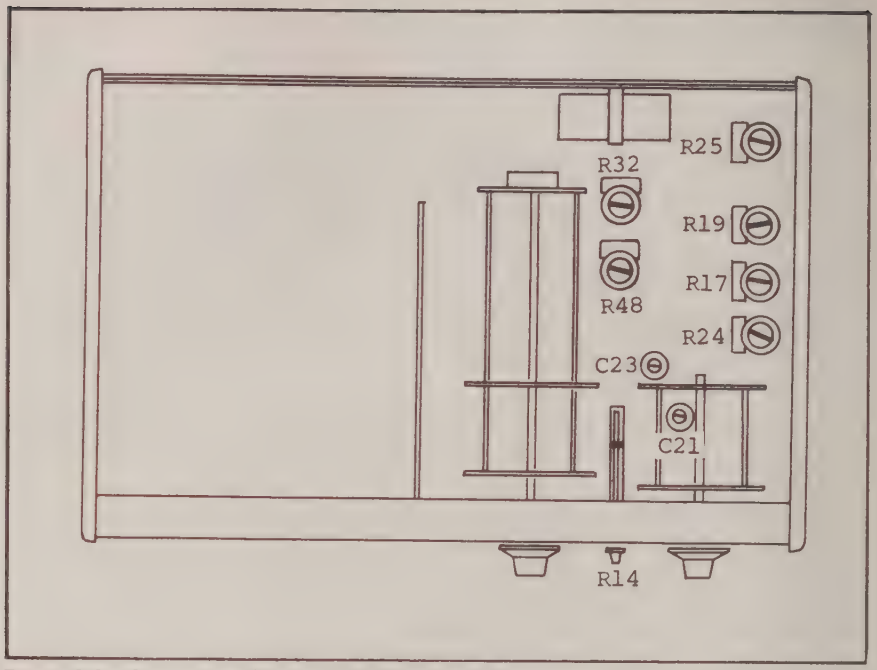



Figure 2-3. External and Internal Calibrating Adjustments

### 2.4.2 ZERO (Front Panel, R14)

Function Select: DCmA
Range Select: 1
Input: Short "HI" to "LO"
Procedure: Adjust R14 (front panel ZERO) for display of "000"

### 2.4.3 A/D ZERO (Internal, R19)

Function Select: DCV
Range Select: 1
Input: Short "HI" to "LO"
Procedure: (a) Adjust R19 for display of "000" with flickering minus sign.

### 2.4.4 Fine Zero

Repeat 2.4.2 and 2.4.3 until no further adjustment is needed.

### 2.4.5 Ohms Adjust (DC ADJ, R25; 10 MEG ADJ, R32)

Function Select: KΩ
Range Select: 10
Input: Connect 10 KΩ ± 0.1% resistor between HI and LO.
Procedure: Adjust R25 for reading of 10.00 or value of known resistor.

### 2.4.5.1 Ohms Adjust (10 MEG ADJ, R32)

Switch to 10 MΩ full scale range

(a) Connect 10 MΩ ±0.1% resistor between HI and LO terminals
(b) Adjust R32 for reading of 10.00, or known value of resistor.

### 2.4.6 DC Voltage (A/C CAL, R48)

Function Select: DCV
Range Select: 1
Input: 1.000 VDC
Procedure: Adjust R48 for display of "1.000".

### 2.4.7 AC Voltage (AC ADJ, R24; AC TRIMS C21, C23)

Function Select: ACV
Range Select: See table
Input: See table
Procedure: See table for adjustment and reading on display.

AC Voltage Calibration

| Range | Input Signal | Adjustment | Display |
|---|---|---|---|
| 1 | 1.000 VRMS, 1 KHz | R24 | .996 |
| 10 | 10.000 VRMS, 1 KHz | C21 | 9.96 |
| 100 | 100.000 VRMS, 1 KHz | C23 | 99.6 |

### 2.4.8 DC Current (X10 ADJ, R17)

Function Select: DCmA
Range Select: 1
Input: Apply 100 mV between HI and COM
Procedure: Adjust R17 for display of "1.000"

THE INSTRUMENT IS NOW COMPLETELY CALIBRATED.

## Chapter 3

# PRINCIPLES OF OPERATION

## 3.1 OVERALL BLOCK DIAGRAM

As shown in figure 3-1, the Data Precision Model 134 Digital Multimeter consists of the following major functional blocks:

a) Input Signal Conditioner – contains the proper attenuators and shunts to scale the input voltages to 1 volt full scale; input currents to 100 mV full scale, and to program drive currents for measurement of resistances.

b) Input Signal Buffer/Amplifier – contains FET input programmed gain amplifier to provide a very high input impedance and to obtain a gain change of 10 where needed so that all input signals to the converter will be scaled for 1 volt full scale sensitivity.

c) Voltage to Current Converter – contains the amplifiers and gates to generate a current proportional to the absolute value of the voltage from the Buffer/Amplifier; introduces a scaling factor for AC measurements so that the input signal will be scaled in RMS units. This circuit also generates the display indication for negative polarity input signals.

d) The A/D Converter – contains the charge-discharge capacitor whose voltage is linearly charged by the input current, a reference, and comparator/timer to convert the input signal current into a frequency of up to 2,000 counts per 49 source power cycles for full overrange, and to generate appropriate sign indicators to the display.

e) The Control Logic – contains timing generators, registers, and gates to generate the control signals for A/D conversion cycle, and to latch the A/D output count into storage registers for decoder driver action and display.

f) The Display – contains decoder/drivers and one-half inch high, bright self-illuminated 7-segment plasma planar numerals, minus polarity sign, and decimal point display.

g) The Power Supply – contains voltage transformer, rectifiers, and regulators to supply ±5V, ±9V, –10V, –18V and ±180V for logic, analog, reference, and display power requirements.

## 3.2 CONTROLS AND ADJUSTMENTS

Figure 3–1 also identifies the significant operating controls and adjustments and indicates their block of operation in the measurement process.

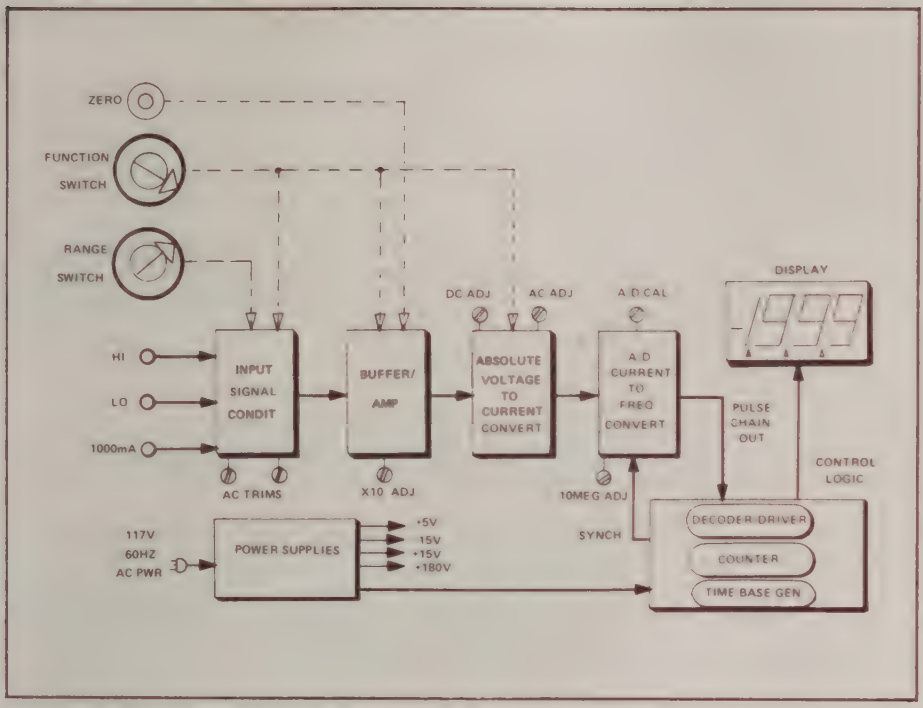



**Figure 3-1. Overall Block Diagram**

### 3.2.1 Front Panel Controls

**a)** The Function Switch – connects the input signal to the appropriate attenuators, shunts or current drives for voltage, current, or resistance measurement, respectively; introduces the X10 gain amplification for current and resistance measurements; and introduces the gain conversion factor in the Absolute Value Converter block for AC measurements.

**b)** The Range Switch – programs the precision attenuator network, current shunt network, or current drive circuit for the selected full scale range of voltage, current, or resistance measurement, and positions the decimal point for direct reading values.

**c)** Zero (Front Panel) – balances the input signal differential buffer/amplifier for any inherent unbalance in the two-channel circuit.

### 3.2.2 Internal Calibration Controls

**d)** AC Trim (two) – Trimming capacitors in parallel with resistances in the precision signal conditioner network to calibrate the network for AC signal inputs.

**e)** X10ADJ (one) – Potentiometer to adjust the gain of the X10 programmed gain amplifier for precise signal amplification and scaling.

**f)** DC ADJ (one) – Potentiometer to adjust the gain factor of the absolute voltage-to-current converter for full scale sensitivity of 1,000/1 volt.

**g)** AC ADJ (one) – Potentiometer to introduce a gain factor of 1.11 to convert the measured value into RMS units when measuring AC input signals.

**h)** A/D CAL (one) – Potentiometer to adjust the reference current when calibrating the converter for full scale range sensitivity.

**i)** 10 MEG ADJ (one) – Potentiometer to program the drive currents for high resistance measurements.

## 3.3 CIRCUIT SCHEMATIC

The complete schematic for the Model 134 Multimeter may be found at the end of Chapter 3 and should be referenced for details of the explanations that follow. Simplified schematics are included in the brief descriptions of the circuit operation that follow.

## 3.4 INPUT SIGNAL CONDITIONER

Figure 3–2 illustrates the operation of the switching circuit in programming the precision resistor and shunt networks in the different measuring modes. The following operational comments may be observed:

**a)** In voltage measurements, the full 10 megohm high input impedance is always presented to the measured circuit.

**b)** In AC voltage measurements, the distributed capacitance across R1 is sufficient for trimming purposes, and no additional trimmer need be added. Series capacitor C17 removes the DC components from the input signal.

**c)** In current measurements on the 1, 10, and 100 mA ranges diodes D10 and D11 limit the voltage across the shunt resistors to a safe value for protection purposes, and fuse F1 provides fail-safe protection should the current exceed 2.5 amperes.

**d)** In current measurements of signals through the 1000 mA input connection, no protection is provided.

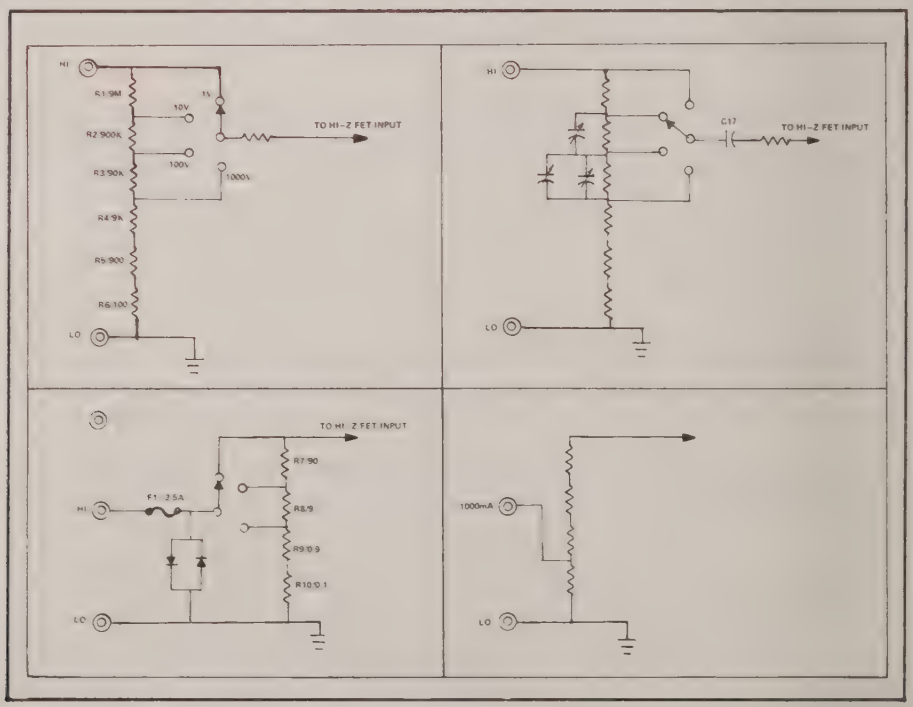



**Figure 3-2. Signal Conditioning Simplified Schematic**

## 3.5 BUFFER/AMPLIFIER

Refer to the complete schematic (figure 3-6) for circuit details.

a) When R14 (Front Panel ZERO) is adjusted properly, the input differential FET stages are balanced, and the output IC2 pin 7 then follows the input to Q1 (see figure 3-2) (X1-0) in Voltage and Resistance measuring functions.

b) When the instrument is used in current measuring function, the feedback path around IC2 is modified to introduce a gain of 10 (adjusted by R17).

c) Protection of the input circuit against voltages in excess of ±9.4 volts is provided by FETs Q1 and Q2.

## 3.6 ABSOLUTE VOLTAGE-TO-CURRENT CONVERTER

Figure 3-3 is a simplified block/schematic of the circuitry that generates a unidirectional current proportional to the magnitude of the input voltage (after the Buffer/Amplifier stage). The illustration also includes the block schematics of the A/D circuit to convert this unidirectional current to a proportional output frequency.

a) When the A/D Zero (Internal R19) adjustment is accomplished, the upper part of the feedback resistor $R_{FB}$ is effectively at reference zero level.

b) For positive inputs from the Buffer/Amplifier Diode D4 is forward biased, removing Q5 and Q6 from the circuit. The current which flows through the feedback resistor (which now has the same positive level as the input voltage at its junction with D4) passes through the Q7, Q8 transistor pair, and charges C1 as shown in figure 3-3.

c) For negative inputs from the Buffer/Amplifier, Diode D4 is backbiased, but transistor Q5, Q6 conduct the current which flows through the feedback resistance (which now has a negative level at its junction with V4) passes through D3 while Q7, Q8 are cut off. In this way, for either positive or negative signal inputs, the signal current $I_S$ flows in the same direction at the junction of Q5, Q6 and Q7, Q8, charging C1 in the same direction for either input.

## 3.7 CURRENT-TO-FREQUENCY CONVERTER

a) As shown in figure 3-3 and the complete schematic of figure 3-6, the unidirectional current $I_S$, charges C1 continuously throughout the measurement at a rate determined by the input signal. A discharge current, $I_D$, is switched in and out of the integrating capacitor circuit by the action of switching gate D6, D7, and this current is of sufficient magnitude to completely overcome the effect of signal current $I_S$, and to discharge the capacitor until it reaches its nominal level of 15 volts. The discharge current path $I_D$ is switch into the circuit through the closing of gate D6, D7 when the charged capacitor reaches a voltage level of a nominal −5V, and it continues to discharge the capacitor for a fixed time interval, $T_R$ determined by the time constant of R57C2 (figure 3-6).

b) As shown in the waveform schematic included in figure 3-3, the sequence of actions for a particular input signal current $I_S$ established a repetitive pattern in the following way.

1) The charging current, $I_S$, charges capacitor C1 for a time, t, at a rate determined by the magnitude of the input signal.

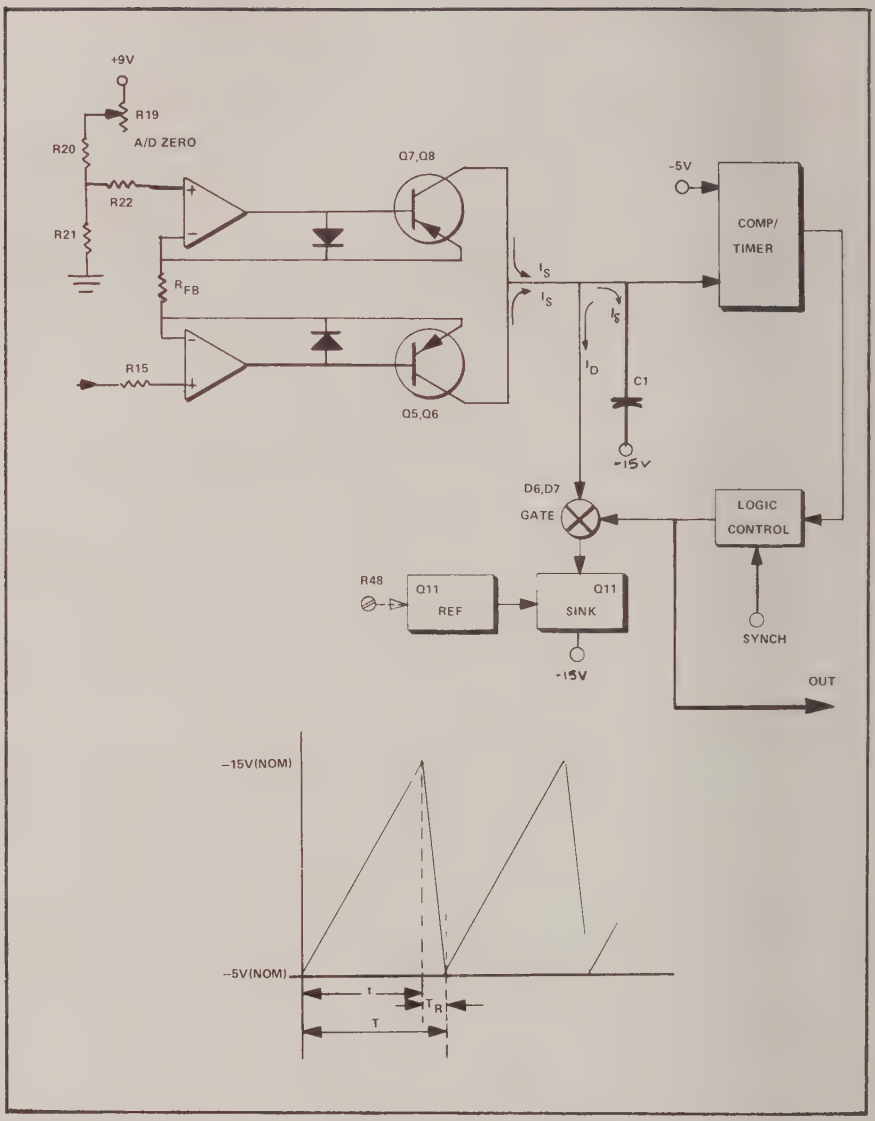



Figure 3-3. Absolute Voltage-to-Frequency Conversion Simplified Block Schematic

2) Switching gate D6, D7 is open, and the capacitor C1 charges up to the nominal –5 Volts;

3) The Comparator/Timer, senses the level reached by the charged capacitor, and generates a control signal to close gate D6, D7, and to reduce the charging current $I_S$ by the discharging current, $I_D$.

4) Capacitor C1 is discharged for a fixed time, $T_R$; when gate D6, D7 is once again opened, removing the discharged current, $I_D$, from the circuit.

5) The cycle repeats steps (1) through (4) for a total of 49/60 of a second (49 cycles of a 60-cycle power source). The frequency (no. of charge–discharge cycles in 49/60 second) is the desired conversion.

c) On the 50th power source cycle, a synchronizing signal derived from the power source resets the circuit and removes any residual charge on C1 prior to the next conversion.

## 3.8 CONTROL LOGIC

The control logic circuit is shown in the complete schematic of figure 3–6, and is indicated in the simplified block of figure 3–4. The AC signal from the power transformer tap is counted down by IC's 10A and 11A and by gate IC19 to develop a synchronizing signal of one power–source cycle duration in each 50 cycles of line timing.

At the start of the synch cycle, a transfer signal, initiated by the synch signal, transfers the contents of the counter, comprised of IC 12, 13, 14, and 11, to the latches (IC 16, 17, 18, and 15), and thence to decoder drivers IC 101, 102, and 103 for the 7–segment digits display, and Ic 19 and Q101 for the MSB "1" display.

If the count exceeds 1999, IC10B receives an overflow count from IC11B and the overload sense flip flop IC20 is set developing a blanking signal through IC15.

The timing relationships among the digital control signals are summarized in figure 3–5.

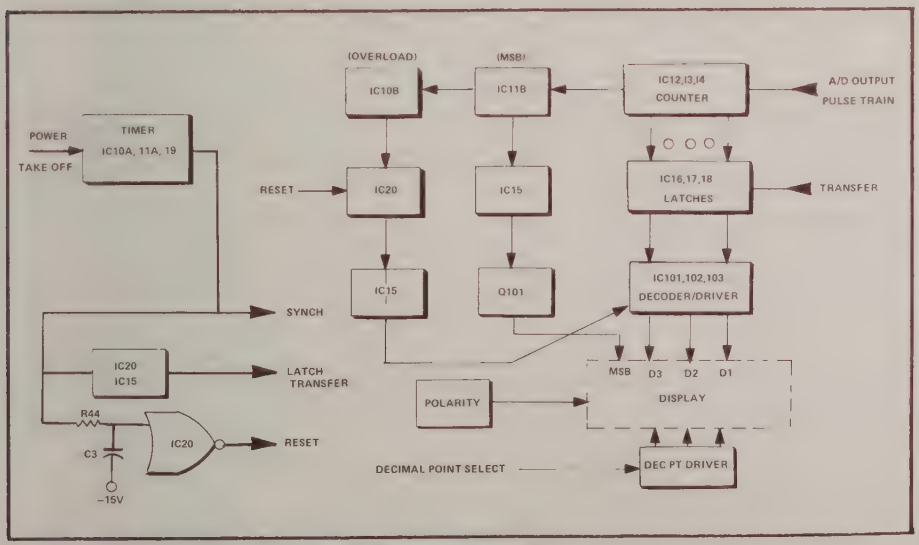



**Figure 3-4. Control Logic Simplified Block Diagram**

## 3.9 POWER SUPPLY (See Complete Schematic, figure 3-6)

The power supply generates 5 regulated voltages. Series pass regulation is provided for the +180V display supply and for the 5 Volt logic supply; zener shunt regulation supplies +9V, −15V and −18V.

Q13 together with R41 and D15 form a low impedance emitter follower output. C15 eliminates zener noise that could couple into the input buffer amplifier via the decimal point switch. R45 is a current limiting resistor, protecting the outputs of IC101, IC102 and IC103.

The analog supply levels +9V, −15V and −18V are developed across zener diodes D12, D13 and D14 which are driven by the current limiting resistor R42. C13 across D13 suppresses transients during the SYNC time interval when Q11 in the reference current source saturates and IC2B, via the +9V supply, has to source 8.7mA. By-passing is provided on all three supplies by C7, C8 and C9.

The 5V logic supply has its "ground" at the −15 Volt analog level so that the +5 Volt appears as −10 Volts with respect to common ground, i.e., the cathode of D13. The Darlington Q14 gets its base drive from the 6.2V reference zener D9 so that the voltage across bypass capacitor C6 is 5 Volts.

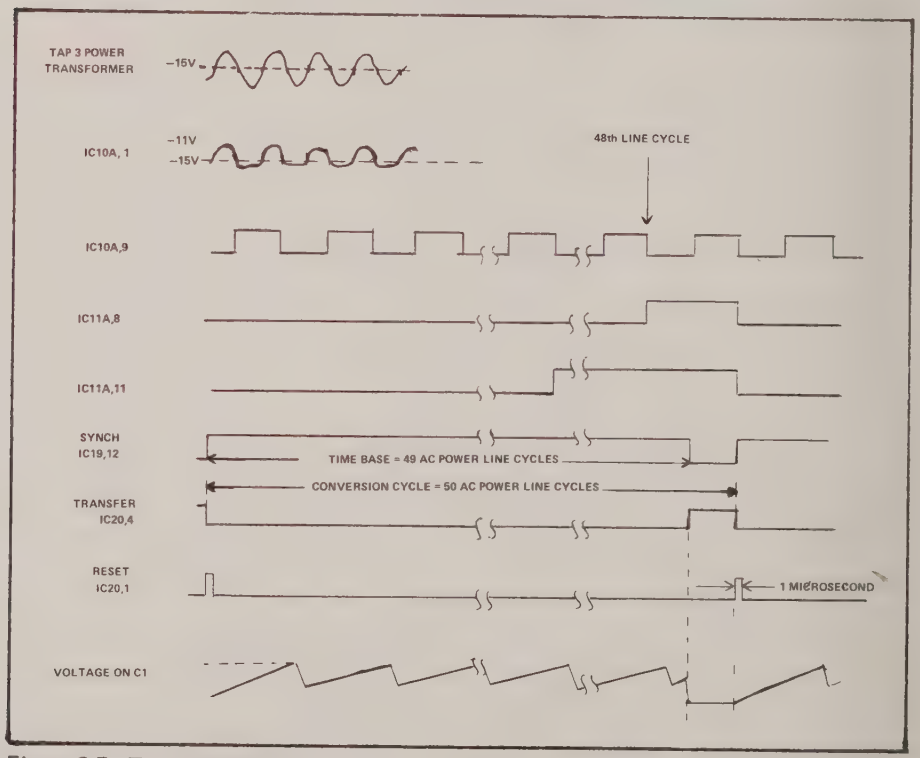



**Figure 3-5. Timing Waveforms**

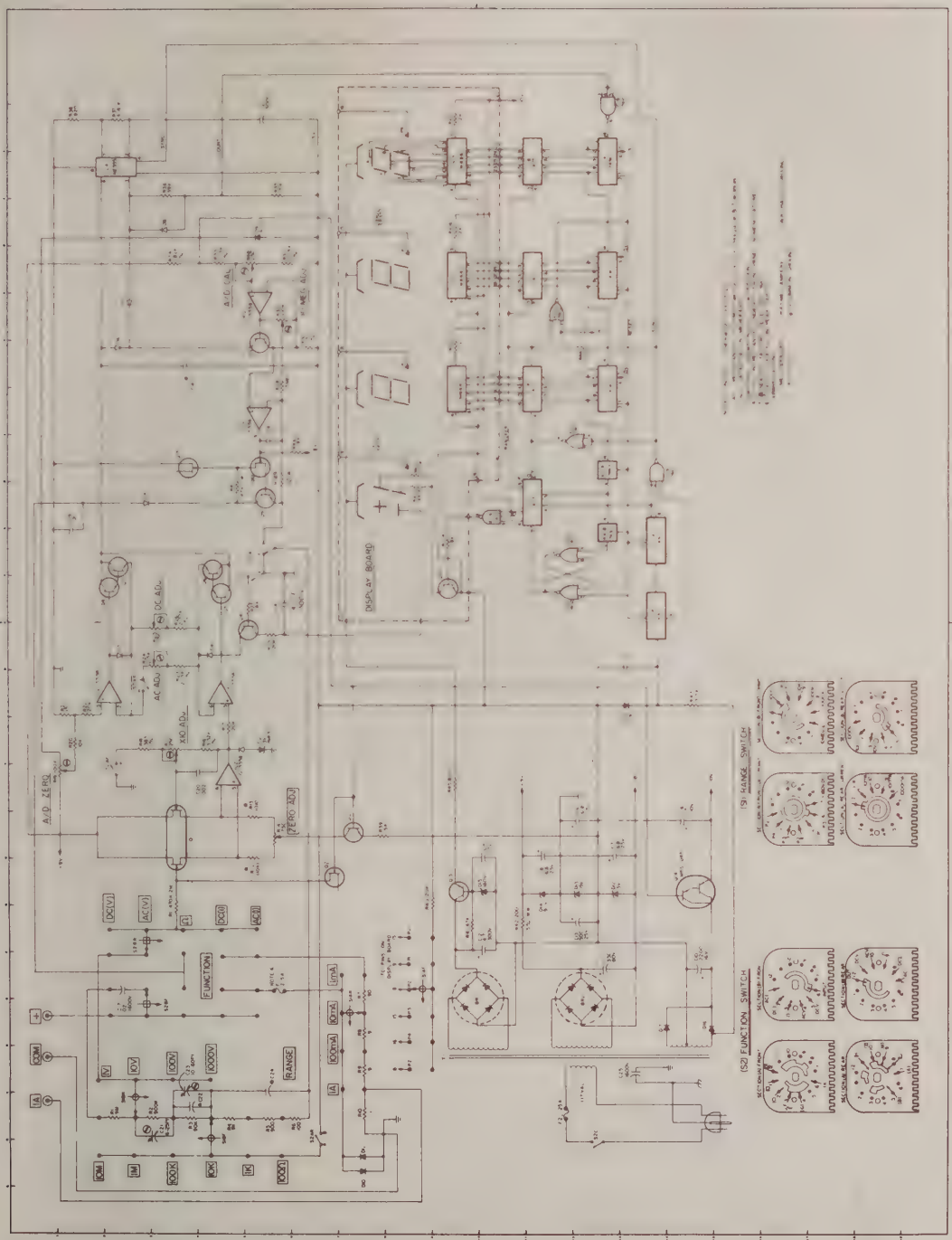



**Figure 3-6. Complete Schematic**

## Chapter 4

# MAINTENANCE

## 4.1 GENERAL

Performance of the Model 134 Multimeter is covered by Warranty for a period of one-year, and users are cautioned about making repairs to the instrument during its warranty period. Indications of apparent malfunction should be verified by repeating the measurement (if possible), and checking carefully to see that probes are connected properly, that the proper range scale is selected, and that the correct measurement function is selected. Calibrating adjustments should be checked at regular intervals (3 to 6 months), and verified when meter "apparent malfunction" is a matter of degree and not one of "catastrophe". The fuse mounted on the inner side of the rear panel should be checked when apparent "complete malfunction" is observed.

## 4.2 TROUBLE-SHOOTING AND FAULT DIAGNOSIS

Although experienced maintenance technicians may *quickly* isolate the cause of malfunctioning meters by recognizing familiar symptoms, a standard trouble-shooting routine can be applied whereby a technician of moderate experience will isolate the cause of most meter malfunctions within a reasonably short time. In graphic terms, the standard approach to trouble-shooting is shown is figure 4-1. As illustrated in figure 4-1, one proceeds from external to internal analyses by considering the multimeter as an assembly of major functioning groups. These are:

a) The interfacing founctions
   Signal connections
   Power connections

b) The power supply
   checking the generation of regulated internal supply voltages

c) Signal conditioning function

d) Logic and control functions

e) Display function

f) Analog-to-digital conversion function

In general, one examines the performance of these functioning groups to determine whether they are *functioning correctly,* and to conclude that the circuits involved do not contain the malfunctioning component. By eliminating the "good" circuits, it is possible to narrow the search for the causal component.

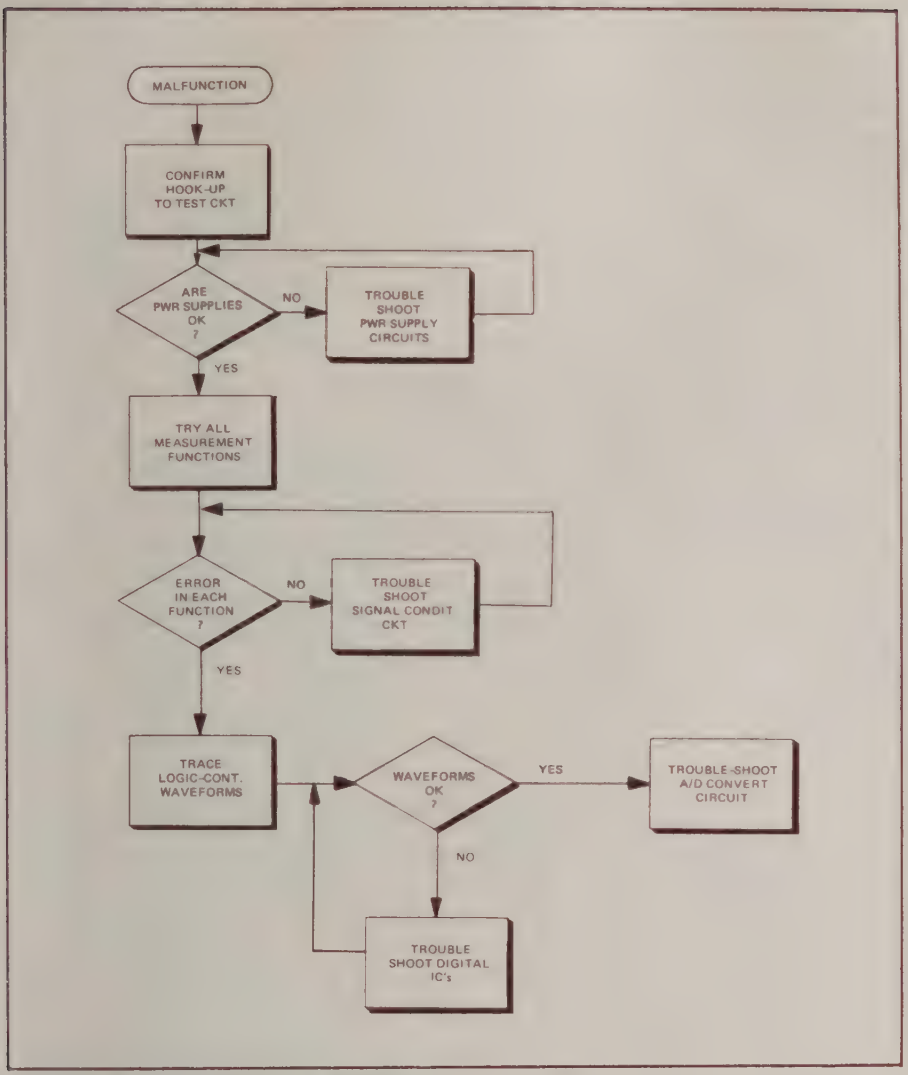



Figure 4-1. Trouble-Shooting Strategy

## 4.3 MAINTENANCE AIDS

a) The simplified schematics of Chapter 3, and the principles of operation of the circuits included in Chapter 3 should be consulted in checking the performance of the circuit functions. Chapter 3 also includes waveforms that may be checked at appropriate circuit points.

b) Figure 4-2 is an illustration showing the location of components on the PC-Board assembly. All components are mounted on top of the PC-Board, and the board is marked with component reference designations.

c) A partial list of precision replaceable electronic parts is appended to this chapter, and each part is described in general terms for easy technician use. The schematic contains adequate information of the remaining "standard" electronic parts.

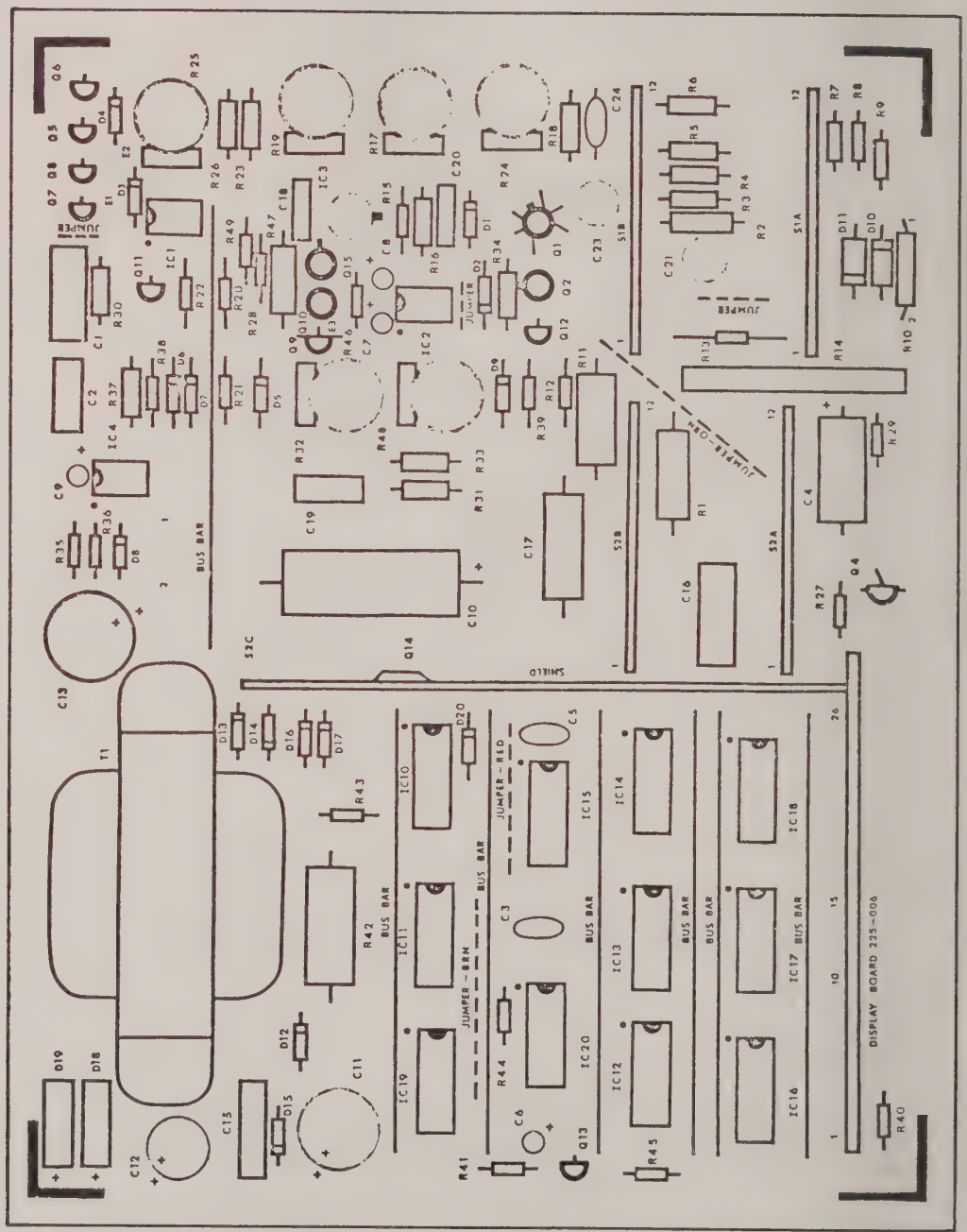



Figure 4-2. Component Parts Layout and Identification

# MODEL 134 DIGITAL MULTIMETER

## REPLACEABLE PARTS

| SCHEMATIC SYMBOL | DESCRIPTION |
|---|---|
| BR1 | Diode, Rectifier Bridge 100V |
| BR2 | Diode, Rectifier Bridge 300V |
| C1 | 0.04μf 5% 100V Mylar Capacitor (Factory Selected) |
| C2 | 0.005μf 5% 100V Mich. Capacitor |
| C4 | 4.7μf 300V Alum. Capacitor |
| C6 | 15μf 10V Tantalum Capacitor |
| C7,8,9 | 6.8μf 25V Tantalum Capacitor |
| C10 | 2200μf 16V Alum. Capacitor |
| C11 | 350μf 80V Alum. Capacitor |
| C12 | 4.7μf 300V Alum. Capacitor |
| C13 | 500μf 25V Alum. Capacitor |
| C17 | 0.02μf 1600V, Mylar Capacitor |
| C21, C22 | 6-25 pf Trimmer Capacitor (Factory Selected) |
| C23, C24 | 10-60 pf Trimmer Capacitor (Factory Selected) |
| C25 | 0.1μf 20% 1600V Capacitor |
| D1,3,4,6,7 | Diode, Silicon, IN4148 |
| D2,12 | Diode, Zener 3.0V 5% 400mW, IN748 |
| D5 | Diode, Rectifier, IN4004 |
| D8 | Diode, Silicon, A14-140001 |
| D9 | Diode, Zener Ref, IN823 |
| D10,11 | Diode Protection, Silicon, A225-030 |
| D13 | Diode, Zener 15V 5% 1W, IN4744A |
| D14 | Diode, Zener 9.1V 5% 1W, IN4739A |
| D15 | Diode, Zener 180V 10% 1W, IR180B |
| D20 | Diode, Zener 3.9V 10% 400mW, IN748 |
| DS1 | Display, Sperry SP351 |
| DS2 | Display, Sperry SP352 |
| F1 | Fuse, 3AG 2½ Amp |
| F2 | Fuse, ¼A Slo-Blo Pigtail |

| | |
|---|---|
| IC1,2 | I.C. NE5558 |
| IC3 | I.C. NE5556 |
| IC4 | I.C. N555 |
| IC10,11 | I.C. 7493 |
| IC12,13, IC14 | I.C. 7490 |
| IC15,16, IC17,18 | I.C. 7475 |
| IC19 | I.C. 7410 |
| IC20 | I.C. 7402 |
| IC101, 102,103 | I.C. DM8880 |

| | |
|---|---|
| Q5,6,7,8 | Transistor, PNP, Silicon, MPS6519 |
| Q9 | Transistor, NPN, Silicon, MPS A42 |
| Q10 | Transistor, FET, A225-037 |
| Q11,12 | Transistor, NPN, Silicon, 2N3904 |
| Q14 | Transistor, NPN, Pwr. Darlington, MPS-U45 |
| Q15 | Transistor, FET, N Channel, A225-036 |
| Q101 | Transistor, NPN, Silicon, DTN203 |

| | |
|---|---|
| R1 | 9 Meg (1000V) ±.25%, 100ppm |
| R2 | 900K± .25%, 100ppm |
| R3 | 90K±.25%, 150ppm |
| R4 | 9K±.25%, 100ppm |
| R5 | 900Ω±.5%, 100ppm |
| R6 | 100Ω±.5%, 100ppm |
| R7 | 90Ω±.5% WW ½W |
| R8 | 9Ω±.5% WW ½W |
| R9 | 0.9Ω±.5% WW ½W |
| R10 | 0.1Ω±.5% WW 1W |
| R14 | Trimmer, 1K |
| R16 | 3.32K, 1% RN 60D |
| R17,48,25 | Trimmer 250 |
| R18 | 383Ω 1% RN 60D |
| R19,32 | Trimmer 100K |
| R20 | 10K, 5%, ¼W Deposited Carbon only |
| R21 | 15Ω 5% Deposited Carbon only |
| R23 | 21.5K, 1% RN 60D |
| R24 | Trimmer 2.5K |
| R26 | 2.37K, 1% RN60D |
| R28 | 15 Meg, 10% Carbon Composition Only |
| R30 | 115Ω 1% RN 60C |
| R31 | 2.15K 1% RN 60C |
| R33 | 11.3K 1% RN 60C |
| R34 | 1.82K, 1% RN 60D |
| R37 | 6.8K 1% RN 60C |
| R42 | 200Ω±5%, 5W, WW |

| | |
|---|---|
| S1 | Switch, Range S1 D225-011 |
| S2 | Switch, Function S2 D225-012 |

| | |
|---|---|
| T1 | Transformer C225A-046 |

MP MASTER
MA28612

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